

Ring around the Exoplanet

Maggie: Welcome to Blueshift, brought to you from NASA's Goddard Space Flight Center. I'm Maggie Masetti. Last year, we brought you a story from the 2012 American Astronomical Society meeting about bizarre and perhaps uncommon exoplanet systems. One of the presenters was a college friend of mine, Eric Mamajek, and he discovered an exoplanet system that they suspect has rings similar to Saturn's.

Our last two podcasts featured our interview with space artist, Ron Miller, who did an illustration for this exoplanet system. Now we'll talk to the scientist who discovered it to learn more.

Maggie: We covered the exoplanet session you presented at AAS last year so we thought it'd be fun to kind of catch up with you a year later. Backing up a little bit, can you tell us about this, perhaps unusual, exoplanet system you discovered and how you came to find it?

Eric: Well, we found it as an unusually eclipsing system among a survey of hundreds of new very young stars we've discovered. So my graduate student, Mark Pecaut, is doing a survey, looking for, essentially, baby suns and stars like the sun but only about 10 to 20 million years old in the nearest region of massive star formation, which is the Scorpius Centaurus Complex. So, if you're in the southern hemisphere, you can see a lot of the brightest members of the group in the night sky and Scorpius and Centaurus, and Crux and Lupus... some of those constellations. We had found that a lot of the objects that we had discovered as young, sun-like stars had been looked at by the survey called SuperWASP, which is a very tiny telescope that is imaging large regions of the sky looking for transiting exosolar planets.

They're looking for little dips in the signal among the bright stars in the sky, looking for planets passing in front of those stars. We were looking at data from that survey for our stars, and one of the stars had this huge, very unusual eclipse in it. That's where this got started. But, as soon as we saw the eclipse, we thought, "Well, this doesn't look like any sort of eclipse we've ever seen." The eclipse was going on over a period of about 52 days, at its deepest, about 95% of its star's light had been blocked out. This was a very odd eclipsing object.

Maggie: What do you think caused the eclipsing of the light?

Eric: The best model we have so far... I have a graduate student Erin Scott, who's following up on the modeling of this system. The eclipsing object seems to be a series of rings. It seems to be a fairly dense inner disc surrounded by several discrete rings and we're currently figuring out how to

statistically distinguish, you know, how many rings are there, and how dense are they?

But it looks like there's a series of rings. And by rings, I mean they're probably composed of dust and they're probably fairly thin, like Saturn's rings, though the system appears to be much, much larger than Saturn's system. You know, a lot of people have found things around stars that they've called ring systems, but they're not really ring systems. They're usually these so-called "debris discs." The discs are on Fomalhaut and Vega, Beta Pictoris... Those are a few famous examples.

Those appear to be ground up dust from collisions of asteroids and comets over a very large scale, and they appear to be fairly puffed up. They're not very thin; whereas this system, the thinning of the light curve requires that these rings are very, very thin, almost like Saturn's rings. Although we don't have a very strong constraint on how thin they are. But we see very clean gaps between them. Something must be creating these gaps in the rings.

Maggie: I was gonna ask, is that the first time something like has been seen? You mentioned these other systems might have puffy debris discs, but is this the first time we found an exoplanet that might have Saturn-like rings?

Eric: Well, I want to be careful because we don't quite know the nature of the object yet. Probably either a giant planet or a brown dwarf. Some sort of a failed star, a substellar object. It could be something that's tens of times the mass of Jupiter, but we've ruled it out being stellar. It doesn't appear to be a low mass star with a little disc around it. So I think right now it's probably consistent with being a giant planet or brown dwarf. But either way, it's still a very remarkable system.

I think it's going to be some time before we know the mass of that companion. We're going to continue to take data over the next few years and see where that goes. But there's some suspicious inconsistencies. If the object's too massive, it doesn't appear to have an inner gap. We don't detect a hole in the disc, so if it was a low mass star there should be a point at which the temperature's too high for dust to exist and the little [?] would just evaporate because it would be too hot.

So we think it's cooler. We think it's probably a brown dwarf or a giant planet. But either way, we're talking, you know, with this ring system and the gaps in these rings and if there's something in there creating the gaps, we're talking about if it's a brown dwarf, we're talking about a very tiny, miniature planetary system around a brown dwarf. I guess you'd call it a planetary system. Or, if it's a giant planet, we're talking about moons, carving things out.

But I think we have to be a little bit careful. I think we're not going to know

exactly what the nature is of this companion is that has this very complex ring system. I think it's going to be a little while before we know exactly what that is. But the whole system appears to be smaller than perhaps a few tenths of an astronomical unit. So, I mean, you could fit it within the orbit of Mercury in our own solar system. It could be even smaller than that.

Maggie: The exoplanet session at AAS last year, the theme was sort of "anything can happen with exoplanets." What are your thoughts on that? The fact that so many interesting and weird systems are being discovered?

Eric: This is a great time to be studying this topic. It's amazing to think even 15 years ago, we knew of one or two planetary systems outside the solar system. Now we know of many hundreds. NASA's Kepler satellite has found over 2,000 candidates. Most of those are probably real planetary systems. It'll take a long time to confirm them through other means. You know, literally we're finding planetary systems everywhere, and we're seeing interesting patterns in the types of planets and their characteristics.

The thinking two decades ago that we would just find a whole bunch of clones like our solar system is out the window. We're finding very strange planetary systems; we're finding giant planets orbiting very close in; we're finding very, very compact, tiny planetary systems around some objects. In the Kepler field, they're finding things that are sort of intermediate between Earth and Neptune. They're either mini Neptunes or super Earths, so scientists are still trying to constrain what the properties of these things are.

There are classes of planets out there that don't exist in our own solar system. We're finding our solar system does not appear to be typical.

Maggie: What's funny is that when we were college, the first exoplanet discovery was pulsar planets, which isn't exactly what you would think of as a normal star system either. But it is funny how far we've come since then.

Eric: Yeah, that was around 1991, 1992. And I think there's only been a couple other planets discovered on pulsars, if any. That was a very strange system that was discovered.

Maggie: It's funny that that was the first one, though. Just such an odd, oddball system.

Eric: Yeah, and so far they haven't... again, they haven't really been found in great number around other pulsars so that appears not to be a terribly good birth site for planets. There was a trend that people were finding about five or ten years ago. They were finding that stars that had more metal content than the sun, so things like iron, nickel, magnesium, silicon – stars that have chemical composition that has more metals, what astronomers call metals, other fields may not call them metals.

First off, anything heavier than helium is basically metal. Planets need metals to form. There was this trend found that the more metal rich a star was, there was a stronger tendency for those stars to have planets. But they're also finding that there's trends in the types of planets that are found. They're tending to find those close-in Jupiters more around the metal rich stars, but they're also finding these stars that have lower metal composition, they tend to have smaller planets.

So, even these stars that you would think that the discs that they formed out of probably had less materials to form planets, the process must be going on. But I think the Kepler results are showing us that even these metal poor stars can form planetary systems so there's probably lots and lots and lots of very small planets out there.

Maggie: When we were just starting out in astronomy at Penn State, again the pulsar planets were sort of the first thing out there, what was it that made you eventually study exoplanets? Was there something that triggered your interest back then or was it something you just fell into?

Eric: Well, I've been interested in astronomy since I was around eight years old, and I remember some of the interesting, tantalizing clues that there might be planets out there. That was certainly an interesting motivator for me. People had found some substellar objects in the late 80s and early 90s. They found the pulsar planets in the early 90s. They found a companion around... the first hot Jupiter was discovered in 1995. It was this Jupiter-like planet orbiting a sun-like star. In four days, a sort of barbecued gas giant. They found that in 1995.

So, it was clear that this was going to be a new, interesting field to get into. But most of my work has been on studying the discs around stars as sort of either a... studying of the initial conditions of planetary systems or the ground up dust that's created from the asteroid belts around those stars. And finding young stellar populations where we can study the birth of these discs and planets, and assessing the ages of stars, that's where most of my work has been. This eclipsing system has been a bit of a surprise, and a really fun project to work on.

Maggie: Do you think you might want to look for other exoplanet systems, or are you just going to focus on learning all you can about this one?

Eric: Well, that's a good question. Certainly this discovery spurred some work by myself, my students and a few collaborators, and we're looking for more of these and I think this may be a fruitful technique for trying to find the signpost of giant planets forming around the very youngest stars.

If this transiting system, we've been calling it J1407, if that really is a giant planet with a moon-forming disc around it, we've done some calculations on how often we think we'd expect to find systems like that. I think this will be

an interesting technique for... once we start finding more of these things, I think that'll give us some of the first observational constraints on the environments where moons are forming around giant planets, the timescale for forming these giant planets. So there's a lot of scientific questions we can answer with those.

So, right now, we're searching. We're looking through some surveys, and so far we're following up one other interesting candidate, but we think it's probably a stellar companion with a disc and it's actually in another galaxy, of all things.

Maggie: Oh, wow!

Eric: We don't think that one's a giant planet, but we're looking.

Maggie: We interviewed the space artist, Ron Miller, and I understand he did art that was representative of your system. Can you tell us anything about that?

Eric: I found that randomly just a few months after our AAS press conference, and I'm a fan of Ron Miller's work, and a book out of the mid 80s, "Out of the Cradle". So, I was in my early teens, and I had a copy of that book.

Maggie: Yeah, I had one too.

Eric: It's a very inspiring book. He's very good at capturing scenery in space, both with humans and without humans in it. Yeah, I was just delighted when I saw that he did some artwork for it. It's now the background on my laptop. I'd like to thank Ron for doing that artwork. I was delighted when I found it.

Maggie: Visit our website at universe.nasa.gov/blueshift to see Ron Miller's art of this exoplanet system and listen to the podcasts where he talks about his work. You can follow us on Twitter or Facebook, where we're NASAblueshift, all one word. We'd love to hear from you, through our blog or any of our social media to get your thoughts on this podcast or what you'd like to find out more about in the future. I'm Maggie Masetti, bringing the Universe closer to you with Blueshift.